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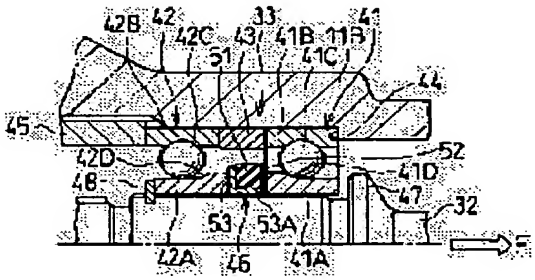
(54) ELECTRIC POWER STEERING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the state of supporting a driving shaft by a bearing device and to improve torque transmission efficiency of an electric motor in an electric power steering device allowing the axial movement of the driving shaft coupled to the electric motor to absorb a shock.
SOLUTION: In the electric power steering device 10, a bearing device 33 supporting the driving shaft 32 coupled to the electric motor 30 is constituted by two angular ball bearings 41, 42, thrust bearing surfaces 41D, 42D provided in the inner rings 41A, 42A of the bearings 41, 42 are placed back to back, an elastic deforming tool 46 is interposed between the inner rings 41A, 42A of both bearings 41, 42, and both inner rings 41A, 42A are clearance-fitted to the driving shaft 32, and clamped between two inner ring locking parts 47, 48.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] While having bearing equipment supported for the driving shaft which the pinion shaft connected to the steering shaft was meshed on the rack shaft, and was combined with the electric motor, enabling free rotation In the electric power-steering equipment which comes to connect with the above-mentioned pinion shaft the middle gear which prepares a drive gear in this driving shaft, and gears on this drive gear Said bearing equipment two angular bearing which equipped the 1 side of the raceway of an inner ring of spiral wound gasket or an outer ring of spiral wound gasket with the thrust abutment When it juxtaposes so that those thrust abutments may become tooth-back doubling, and the inner ring of spiral wound gasket of two angular bearing is equipped with a thrust abutment While pinching between the two inner-ring-of-spiral-wound-gasket stop sections which infixed the elastic-deformation implement between the inner rings of spiral wound gasket of both bearings, and prepared both inner rings of spiral wound gasket in the driving shaft at the running-fit meal and this driving shaft When the outer ring of spiral wound gasket of both bearings is placed in a fixed position to the housing side and the outer ring of spiral wound gasket of two angular bearing is equipped with a thrust abutment Electric power-steering equipment characterized by coming to place in a fixed position the inner ring of spiral wound gasket of both bearings to a driving shaft side while pinching between the two outer-ring-of-spiral-wound-gasket stop sections which infixed the elastic-deformation implement between the outer rings of spiral wound gasket of both bearings, and formed both outer rings of spiral wound gasket in housing at a running-fit meal and this housing.
[Claim 2] Electric power-steering equipment according to claim 1 whose stop section of the level difference section and another side which one stop section prepared in a driving shaft or housing between the two stop sections which pinch an inner ring of spiral wound gasket or an outer ring of spiral wound gasket equipped with the thrust abutment of said two angular bearing is the stopper ring with which it engages with the slot established in the location which makes this level difference section of a driving shaft or housing, and a fixed distance.
[Claim 3] Electric power-steering equipment according to claim 1 or 2 with which said elastic-deformation implement consists of an elastic body, a washer joined to one field side of an elastic body, and a washer attached to the field side of another side of an elastic body.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to electric power-steering equipment.
[0002]
[Description of the Prior Art] Electric power-steering equipment forms a worm gearing in the driving shaft combined with the electric motor, connects to a pinion shaft the worm gear which gets into gear to this worm gearing, and carries out steering assistance by telling the torque of a motor to a rack shaft while it meshes the pinion shaft connected to the steering shaft on a rack shaft.
[0003] being appropriate — it is alike and, as for the tooth flanks of a worm gearing and a worm gear, moderate backlash is set up from the need on processing and actuation. However, with electric power-steering equipment, the transfer direction of power may be reversed with vibration inputted from actuation of a steering wheel or a road surface. At the time of such a reversal drive, the tooth flank on the background of the tooth flank which had contacted until now [of a worm gearing or a worm gear] moves suddenly by backlash, collides and strikes to a partner's tooth flank, and produces a sound.
[0004] Moreover, with electric power-steering equipment, when the stroke of a rack shaft carries out a quick stop during steering in a tire running aground to a curbstone etc., since an electric motor tends to continue rotating according to inertia even if it stops electric supply, the inertia thrust of the driving shaft joined to the electric motor also has a possibility of inviting damage to a torque-transmission path.
[0005] With the conventional technique, in order for a **** to strike, and to reduce a sound or to prevent damage on a torque-transmission path like a publication to JP,6-39665,U, while constituting the bearing equipment which supports the driving shaft combined with the electric motor in gear housing from two bearing and running-fit carrying out of both the inner rings of spiral wound gasket and outer rings of spiral wound gasket of this two bearing to a driving shaft and gear housing, the disk spring is infixed between both bearings. By this at the time of the reversal drive of electric power-steering equipment, and curbstone riding raising of a tire etc. The disk spring on a driving shaft is pushed in to the bearing of another side by one bearing on a driving shaft, and carries out a compression set, and this driving shaft is made movable with one thing of the two bearing at the one side of shaft orientations. As a result The tooth flanks by relaxation of the impulse force produced in the tooth flank of a worm gearing strike, and reduction of a sound or evasion of damage on the torque-transmission path by the inertia thrust of a driving shaft is aimed at.
[0006]
[Problem(s) to be Solved by the Invention] ** When the bearing equipment which supports a driving shaft in gear housing carries out the compression set of the disk spring between two bearing, a driving shaft moves to shaft orientations with one whole (an inner ring of spiral wound gasket and outer ring of spiral wound gasket) bearing. At this time, the outer ring of spiral wound gasket of one bearing needs to be slippery to gear housing, and the inner ring of spiral wound gasket of the bearing of another side needs to be slippery to a driving shaft. Therefore, as mentioned above, two bearing needs to running-fit carry out of both those inner rings of spiral wound gasket and outer rings of spiral wound gasket to a driving shaft and gear housing, and its backlash of the direction of a path between gear housing and a driving shaft is large, and its support condition of a driving shaft is bad, as a result it spoils the torque convective of an electric motor.
[0007] ** The precharge pressure which the disk spring infixed between two bearing gives to a driving shaft is given by compressing a disk spring beforehand with the locknut of the inner ring of spiral wound gasket prepared in the driving shaft. For this reason, it is necessary to adjust delicately the precompression contraction amount given by the bundle degree of a locknut at a disk spring for permitting shaft-orientations migration of a driving shaft and securing fixed impact absorptivity ability in order [which is the need] to give a pressure beforehand to a driving shaft, and difficulty is in the precompression adjustment which bearing equipment gives to a driving shaft.
[0008] The technical problem of this invention is in the electric power-steering equipment whose impact absorption permits shaft-orientations migration of the driving shaft combined with an electric motor, and is made possible to improve the support condition of the driving shaft by bearing equipment, and improve the torque convective of an electric motor.
[0009] Moreover, the technical problem of this invention has bearing equipment in making highly precise simply a precompression setup given to a driving shaft.
[0010]
[Means for Solving the Problem] While having bearing equipment supported for the driving shaft which invention of claim 1 meshed the pinion shaft connected to the steering shaft on the rack shaft, and was combined with the electric motor, enabling free rotation In the electric power-steering equipment which comes to connect with the above-mentioned pinion shaft the middle gear which prepares a drive gear in this driving shaft, and gears on this drive gear Said bearing equipment two angular bearing which equipped the 1 side of the raceway of an inner ring of spiral wound gasket or an outer ring of spiral wound gasket with the thrust abutment When it juxtaposes so that those thrust abutments may become tooth-back doubling, and the inner ring of spiral wound gasket of two angular bearing is equipped with a thrust abutment While pinching between the two inner-ring-of-spiral-wound-gasket stop sections which infixed the elastic-deformation implement between the inner rings of spiral wound gasket of both bearings, and prepared both inner rings of spiral wound gasket in the driving shaft at the running-fit meal and this driving shaft When the outer ring of spiral wound gasket of both

bearings is placed in a fixed position to the housing side and the outer ring of spiral wound gasket of two angular bearing is equipped with a thrust abutment An elastic-deformation implement is infixed between the outer rings of spiral wound gasket of both bearings, and while pinching between the two outer-ring-of-spiral-wound-gasket stop sections which formed both outer rings of spiral wound gasket in housing at a running-fit meal and this housing, the inner ring of spiral wound gasket of both bearings is placed in a fixed position to a driving shaft side, and it is made to become.

[0011] It is made for invention of claim 2 to be a stopper ring which engages with the slot established in the location where the level difference section and the stop section of another side which one stop section prepared in a driving shaft or housing between the two stop sections which pinch the inner ring of spiral wound gasket or outer ring of spiral wound gasket further equipped with the thrust abutment of said two angular bearing in invention of claim 1 make this level difference section of a driving shaft or housing, and a fixed distance.

[0012] It is made for invention of claim 3 to consist of a washer which said elastic-deformation implement joined to one field side of an elastic body and an elastic body, and a washer attached to the field side of another side of an elastic body further in claim 1 or invention of 2.

[0013]

[Function] According to invention of claim 1, there is an operation of the following ** and **.

** If an excessive thrust acts on a driving shaft at the time of the reversal drive of electric PAWASU tearing equipment, and curbstone riding raising of a tire etc. The elastic-deformation implement infixed between the inner rings of spiral wound gasket of two bearing (or between the outer rings of spiral wound gasket of two bearing) carries out a compression set, and the inner ring of spiral wound gasket of one bearing of the two bearing is displaced relatively to the outer ring of spiral wound gasket of the bearing concerned to shaft orientations (the outer ring of spiral wound gasket of one bearing of the two bearing receiving the inner ring of spiral wound gasket of the bearing concerned) (isolation migration). This eases the impulse force produced in the tooth flank of a drive gear, tooth flanks strike, and a sound is reduced, or damage on the torque-transmission path by the inertia thrust of a driving shaft is avoided.

[0014] ** two bearing -- an inner ring of spiral wound gasket (or -- an outer ring of spiral wound gasket) -- a driving shaft (or gear housing) -- a running-fit meal -- Since the outer ring of spiral wound gasket (or inner ring of spiral wound gasket) of another side is placed in a fixed position in gear housing (or driving shaft), it compares both inside-and-outside rings with what carries out [running-fit]. The backlash of the direction of a path between gear housing and a driving shaft is made small, the support condition of the driving shaft by bearing equipment is improved as a result, and it can improve the torque convective of an electric motor. Furthermore, there is no wear of the sliding fitting section by reducing a running-fit part, and it becomes endurance top dominance.

[0015] According to invention of claim 2, there is an operation of the following **.

** The precharge pressure which the elastic-deformation implement infixed between the inner rings of spiral wound gasket of two bearing (or between outer rings of spiral wound gasket) gives to a driving shaft is immediately defined uniquely with the fixed precompression contraction amount given to an elastic-deformation implement based on fixed spacing which while consists of the level difference section prepared in the driving shaft (or gear housing), and the stop section and the stop section of another side which consists of a stopper ring prepared in the slot make. Therefore,-izing of the precompression setup which is the need and which can define a pressure uniquely only by setup of spacing of the two stop sections beforehand, and bearing equipment gives to a driving shaft can be simply carried out [highly precise] to permitting shaft-orientations migration of a driving shaft and securing fixed impact absorptivity ability.

[0016] According to invention of claim 3, there is an operation of the following ** and **.

** An elastic-deformation implement can be infixed on both sides of an elastic body between adjacency ****** (or between outer rings of spiral wound gasket) between the washers of two sheets, and can carry out elastic deformation of the elastic body stably among those inner rings of spiral wound gasket (or between outer rings of spiral wound gasket).

[0017] ** Since an elastic-deformation implement joins one washer to one field side of an elastic body and attaches the washer of another side to the field side of another side of an elastic body, it can improve the sub **** of these 3 components, and can improve the assembly nature to bearing equipment.

[0018]

[Embodiment of the Invention] The front view which drawing 1 fractures a part of electric power-steering equipment, and is shown, and drawing 2 are II-II of drawing 1 . The sectional view which meets a line, and drawing 3 are III-III of drawing 2 . The sectional view in which the sectional view which meets a line, and drawing 4 R> 4 show the important section expanded sectional view of drawing 3 , and drawing 5 shows the migration condition of a driving shaft, the sectional view in which drawing 6 shows an elastic-deformation implement the important section expanded sectional view in which drawing 7 shows the modification of electric power-steering equipment, the sectional view in which drawing 8 shows the migration condition of a driving shaft, and drawing 9 are the sectional views showing an elastic-deformation implement.

[0019] Electric power-steering equipment 10 has the housing 11 (1st [the] - the 3rd housing 11A-11C) fixed to a car-body frame etc. with a non-illustrated bracket, as shown in drawing 1 R> 1 and drawing 2 . And the pinion shaft 14 is connected with the steering shaft 12 with which a steering wheel is combined through a torsion bar spring 13, a pinion 15 is formed in this pinion shaft 14, and the rack shaft 16 equipped with rack 16A which gears to this pinion 15 is supported possible [horizontal movement] to 1st housing 11A. Steering torque detection equipment 17 is formed between the steering shaft 12 and the pinion shaft 14. In addition, the steering shaft 12 and the pinion shaft 14 are supported by housing 11 through Bearing 12A, 14A, and 14B.

[0020] Steering torque detection equipment 17 has formed two sensing coils 17A and 17B surrounding core 17C of the shape of a cylinder which is engaging with the steering shaft 12 and the pinion shaft 14 in 3rd housing 11C, as shown in drawing 2 . Core 17C is equipped with spiral slot 17G which engage with slider pin 17F of the steering shaft 12 while it is equipped with fluting 17E which engages with guide pin 17D of the pinion shaft 14 and is made movable only at shaft orientations. The steering torque added to the steering wheel is given to the steering shaft 12 by this. According to elastic torsion deformation of a torsion bar spring 13 If the relative displacement of a hand of cut is produced between the steering shaft 12 and the pinion shaft 14 The variation rate of the hand of cut of the steering shaft 12 and the pinion shaft 14 becomes what carries out the variation rate of core 17C to shaft orientations, and the inductance of the sensing coils 17A and 17B resulting from a surrounding magnetic change of the sensing coils 17A and 17B by the variation rate of this core 17C changes. That is, if core 17C moves to the steering shaft 12 side, the inductance of sensing coil 17A of the direction where core 17C approaches increases, the inductance of sensing coil 17B of the direction where core 17C keeps away

decreases, and change of this inductance can detect steering torque.
[0021] In the cylinder part 18 prepared in the part which faces a pinion 15 on both sides of the end of the rack shaft 16 within 1st housing 11A As shown in drawing 2 , the rack guide 19 is built in and the from cartridge of the rack guide 19 (bush 19A) is carried out to the rack shaft 16 side with the spring 21 by which tooth-back support is carried out with the cap 20 put on a cylinder part 18. While forcing rack 16A of the rack shaft 16 on a pinion 15, the end of the rack shaft 16 is supported free [sliding]. In addition, the other end side of the rack shaft 16 is supported by bearing 22. Moreover, the tie rods 23A and 23B on either side are connected with the pars intermedia of the rack shaft 16 with the connection bolts 22A and 22B.
[0022] 2nd housing 11B supports an electric motor 30, as shown in drawing 3 . A driving shaft 32 is combined with the output shaft of an electric motor 30 through a clutch 31, and a driving shaft 32 equips the pars intermedia of a driving shaft 32 with a worm gearing (drive gear) 35 at one while both-ends support is carried out by bearing equipment 33 and bearing 34 at housing 11B. And the worm gear 36 (middle gear) which gets into gear to this worm gearing 35 is fixed to the pars intermedia of the pinion shaft 14. Through engagement of a worm gearing 35 and a worm gear 36 and engagement of a pinion 15 and rack 16A, the generating torque of an electric motor 30 serves as steering assistant force, and is given to the rack shaft 16, and an operator assists the control force given to the steering shaft 12.
[0023] it is constituted using two bearing, the appropriate angular bearing 41 (angular contact ball bearing) which consists of inner-ring-of-spiral-wound-gasket 41A, outer-ring-of-spiral-wound-gasket 41B, and ****** 41C as it is alike and bearing equipment 33 is shown in drawing 4 , and the angular bearing 42 (angular contact ball bearing) which consists of inner-ring-of-spiral-wound-gasket 42A, outer-ring-of-spiral-wound-gasket 42B, and transfer object 42C. At this time, bearing 41 equips the 1 side of the raceway of inner-ring-of-spiral-wound-gasket 41A with thrust abutment 41D, and bearing 42 equips the 1 side of the raceway of inner-ring-of-spiral-wound-gasket 42A with thrust abutment 42D, and bearing 41 and bearing 42 are juxtaposed so that those thrust abutments 41D and 42D may become tooth-back doubling mutually. And it is in the condition which bearing 41 and bearing 42 were inserted in housing 11B on both sides of the spacer 43 among those outer rings of spiral wound gasket 41B and 42B, and attached outer-ring-of-spiral-wound-gasket 41B of bearing 41 to the level difference section 44 of housing 11B, and those outer rings of spiral wound gasket 41B and 42B are placed in a fixed position to the housing 11B side by pressurizing outer-ring-of-spiral-wound-gasket 42B of bearing 42 with the locknut 45 screwed in housing 11B. At this time, bearing 41 and bearing 42 infix the elastic-deformation implement 46 beforehand compressed among those inner rings of spiral wound gasket 41A and 42A, and pinch it between the 1st [which formed both the inner rings of spiral wound gasket 41A and 42A in the running-fit meal and the driving shaft 32 so that relative displacement to shaft orientations might be attained at a driving shaft 32], and 2nd inner-ring-of-spiral-wound-gasket stop section 47 and 48. The 1st stop section 47 is the flange-like level difference section prepared in the driving shaft 32, attachment of inner-ring-of-spiral-wound-gasket 41A of it is enabled, the 2nd stop section 48 is the stopper ring which engaged with the slot established in the driving shaft 32, and the 1st stop section 47 and the 2nd stop section 48 are set as the location which makes a fixed distance required to give desired precompression contraction amount (fixed impact absorptivity ability) to the elastic-deformation implement 46.
[0024] The elastic-deformation implement 46 consists of the elastic body 51 which consists of square cross-section circular ring-like rubber, a monotonous disc-like washer 52 combined with one side face of an elastic body 51 by printing, and a L character cross-section annular washer 53 attached to the side-face side of another side of an elastic body 51, as shown in drawing 6 . A washer 53 is fitted in and attached to the inner skin of an elastic body 51 in cylinder part 53A. And the elastic-deformation implement 46 makes a major diameter and the bore of cylinder part 53A of washers 52 and 53 more equivalent to inner rings of spiral wound gasket 41A and 42A than inner rings of spiral wound gasket 41A and 42A for the outer diameter of an elastic body 51 and washers 52 and 53, and compression of an elastic body 51 is certainly enabled by minding washers 52 and 53 among both the inner rings of spiral wound gasket 41A and 42A. From the bore of an elastic body 51, the method of inside is made to project to coincidence, and the bore of cylinder part 53A of a washer 52 and a washer 53 is made it controllable [the compression stroke edge of an elastic body 51] by attachment with cylinder part 53A of a washer 52 and a washer 53. Namely, the after-mentioned (2-2) (2-3), When the elastic-deformation implement 46 is inserted into two inner rings of spiral wound gasket 41A and 42A and carries out a compression set, let timing which cylinder part 53A of a washer 52 and a washer 53 attaches be the compression stroke edge.
[0025] Hereafter, actuation of electric power-steering equipment 10 is explained.
(1) When the steering torque which steering torque detection equipment 17 detected is lower than a predetermined value, the steering assistant force is unnecessary and don't drive an electric motor 30.
[0026] (2) Since the steering assistant force is needed when the steering torque which steering torque detection equipment 17 detected exceeds a predetermined value, an electric motor 30 drives. The generating torque of an electric motor 30 rotates a driving shaft 32, and is given to the rack shaft 16 through engagement of a worm gearing 35 and a worm gear 36 and engagement of a pinion 15 and rack 16A.
[0027] (2-1) Usually, although reaction force arises between the worm gearing 35 of a driving shaft 32, and a worm gear 36 at the time of actuation, since the precharge pressure which the elastic-deformation implement 46 of bearing equipment 33 has given to the driving shaft 32 is set up more greatly than the reaction force, a driving shaft 32 does not move to shaft orientations (drawing 4). Therefore, the generating torque of an electric motor 30 is told to a worm gear 36 as it is.
[0028] (2-2) When a worm gearing 35 and a worm gear 36 make those tooth flanks contact by existence of those backlash at the time of the reversal drive which the transfer direction of power reverses by vibration inputted from steering of a steering wheel or a road surface, it is **** (2-1) between a worm gearing 35 and a worm gear 36. The big reaction force F arises. In this case, that reaction force becomes large rather than the precharge pressure which the elastic-deformation implement 46 of bearing equipment 33 has given to the driving shaft 32. The elastic-deformation implement 46 infixed among the inner rings of spiral wound gasket 41A and 42A of two bearing 41 and 42 carries out a compression set. It becomes that to which inner-ring-of-spiral-wound-gasket 42A of one side 42 of the two bearing 41 and 42, for example, bearing, is displaced relatively to shaft orientations to outer-ring-of-spiral-wound-gasket 42B of the bearing 42 concerned, and a driving shaft 32 moves to shaft orientations (drawing 5). This eases the impulse force produced in the tooth flank of a worm gearing 35 by the elastic deformation of the elastic-deformation implement 46, tooth flanks strike, and a sound is reduced.
[0029] (2-3) **** (2-1) If the stroke of the rack shaft 16 carries out a quick stop during steering in a tire running aground to a curbstone etc., even if an electric motor 30 has electric supply stopped even if, it is going to continue rotating according to inertia, and the inertia thrust F will act on the driving shaft 32 combined with the electric motor 30. At this time, an inertia thrust exceeds the

precharge pressure which the elastic-deformation implement 46 of bearing equipment 33 has given to the driving shaft 32. The elastic-deformation implement 46 infixed among the inner rings of spiral wound gasket 41A and 42A of two bearing 41 and 42 carries out a compression set. It becomes that to which inner-ring-of-spiral-wound-gasket 42A of one side 42 of the two bearing 41 and 42, for example, bearing, is displaced relatively to shaft orientations to outer-ring-of-spiral-wound-gasket 42B of the bearing 42 concerned, and a driving shaft 32 moves to shaft orientations (drawing 5). This absorbs the inertia thrust which acts on a driving shaft 32 by the elastic deformation of the elastic-deformation implement 46, and damage on a torque-transmission path is avoided.

[0030] Therefore, according to this operation gestalt, there are the following operations.

** If an excessive thrust acts on a driving shaft 32 at the time of the reversal drive of electric PAWASU tearing equipment 10, and curbstone riding raising of a tire etc., the elastic-deformation implement 46 infixed among the inner rings of spiral wound gasket 41A and 42A of two bearing 41 and 42 will carry out a compression set, and inner-ring-of-spiral-wound-gasket 42A of one side 42 of the two bearing 41 and 42, for example, bearing, will be displaced relatively to shaft orientations to outer-ring-of-spiral-wound-gasket 42B of the bearing 42 concerned (isolation migration). This eases the impulse force produced in the tooth flank of a worm gearing 35, tooth flanks strike, and a sound is reduced, or damage on the torque-transmission path by the inertia thrust of a driving shaft 32 is avoided.

[0031] ** Since two bearing 41 and 42 places in a fixed position only inner rings of spiral wound gasket 41A and 42A to a driving shaft 32 and the outer rings of spiral wound gasket 41B and 42B of a running-fit meal and another side place them in a fixed position to gear housing 11B, compare both inside-and-outside rings with what carries out [running-fit]. The backlash of the direction of a path between gear housing 11B and a driving shaft 32 is made small, the support condition of the driving shaft 32 by bearing equipment 33 is improved as a result, and it can improve the torque convective of an electric motor 30. Furthermore, there is no wear of the sliding fitting section by reducing a running-fit part, and it becomes endurance top dominance.

[0032] ** The precharge pressure which the elastic-deformation implement 46 infixed among the inner rings of spiral wound gasket 41A and 42A of two bearing 41 and 42 gives to a driving shaft 32 is immediately defined uniquely with the fixed precompression contraction amount given to the elastic-deformation implement 46 based on fixed spacing which while consists of the level difference section prepared in the driving shaft 32, and the 1st stop section 47 and the 2nd stop section 48 which consists of a stopper ring prepared in the slot make. Therefore,-izing of the precompression setup which is the need and which can define a pressure uniquely only by setup of spacing of the two stop sections 47 and 48 beforehand, and bearing equipment 33 gives to a driving shaft 32 can be simply carried out [highly precise] to permitting shaft-orientations migration of a driving shaft 32, and securing fixed impact absorptivity ability.

[0033] ** The elastic-deformation implement 46 can be infixed among adjacency ****** 41A and 42A on both sides of an elastic body 51 among the washers 52 and 53 of two sheets, and can carry out elastic deformation of the elastic body 51 stably among those inner rings of spiral wound gasket 41A and 42A.

[0034] ** Since the elastic-deformation implement 46 joins one washer 52 to one field side of an elastic body 51 and attaches the washer 53 of another side to the field side of another side of an elastic body 51, it can improve the sub **** of these 3 components, and can improve the assembly nature to bearing equipment 33.

[0035] Drawing 7 - drawing 9 are the modifications of this invention. The point that this modification differs from the example of drawing 4 - drawing 6 is in modification of the configuration of the elastic-deformation implement 46. The elastic-deformation implement 46 of drawing 7 - drawing 9 consists of the elastic body 61 which consists of square cross-section circular ring-like rubber, a monotonous disc-like washer 62 joined to one side face of an elastic body 61 by printing, and a KO character cross-section annular washer 63 attached to the side-face side of another side of an elastic body 61. A washer 63 is fitted in and attached in an elastic body 61 between container liner section 63A and outer case section 63B. And the elastic-deformation implement 46 makes a major diameter and the bore of washers 62 and 63 more equivalent to inner rings of spiral wound gasket 41A and 42A than inner rings of spiral wound gasket 41A and 42A for the outer diameter of washers 62 and 63, and compression of an elastic body 61 is certainly enabled by minding washers 62 and 63 among both the inner rings of spiral wound gasket 41A and 42A. From the bore of an elastic body 61, the method of inside is made to project to coincidence, and the bore of container liner section 63A of a washer 62 and a washer 63 is made it controllable [the compression stroke edge of an elastic body 61] by attachment with container liner section 63A of a washer 62 and a washer 63.

[0036] As mentioned above, although the gestalt of operation of this invention was explained in full detail with the drawing, the concrete configuration of this invention is not restricted to the gestalt of this operation, and even if there is modification of a design of the range which does not deviate from the summary of this invention etc., it is included in this invention. For example, the bearing equipment of this invention infixes an elastic-deformation implement for a thrust abutment between the outer rings of spiral wound gasket of both bearings in preparation for the outer ring of spiral wound gasket of two angular bearing (angular contact ball bearing), and it may place in a fixed position the inner ring of spiral wound gasket of both bearings to a driving shaft side while pinching between the two outer-ring-of-spiral-wound-gasket stop sections which formed both outer rings of spiral wound gasket in housing at a running-fit meal and this housing.

[0037] Moreover, a drive gear and a middle gear may consist of other gearings, such as the gearing which makes what [not only] constitutes a worm reducer but a driving shaft generate a thrust, for example, a helical gear, and bulk ******, in the electric power-steering equipment with which this invention is applied.

[0038]

[Effect of the Invention] As mentioned above, according to this invention, in the electric power-steering equipment whose impact absorption permits shaft-orientations migration of the driving shaft combined with an electric motor, and is made possible, the support condition of the driving shaft by bearing equipment is improved, and it can improve the torque convective of an electric motor.

[0039] Moreover, according to this invention, bearing equipment can make highly precise simply a precompression setup given to a driving shaft.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the front view fracturing and showing a part of electric power-steering equipment.
[Drawing 2] Drawing 2 is II-II of drawing 1 . It is the sectional view which meets a line.
[Drawing 3] Drawing 3 is III-III of drawing 2 . It is the sectional view which meets a line.
[Drawing 4] Drawing 4 is the important section expanded sectional view of drawing 3 .
[Drawing 5] Drawing 5 is the sectional view showing the migration condition of a driving shaft.
[Drawing 6] Drawing 6 is the sectional view showing an elastic-deformation implement.
[Drawing 7] Drawing 7 is the important section expanded sectional view showing the modification of electric power-steering equipment.

[Drawing 8] Drawing 8 is the sectional view showing the migration condition of a driving shaft.
[Drawing 9] Drawing 9 is the sectional view showing an elastic-deformation implement.
[Description of Notations]
10 Electric Power-Steering Equipment
11B Housing
12 Steering Shaft
14 Pinion Shaft
16 Rack Shaft
30 Electric Motor
32 Driving Shaft
33 Bearing Equipment
35 Worm Gearing (Drive Gear)
36 Worm Gear (Middle Gear)
41 42 Bearing
41A, 42A Inner ring of spiral wound gasket
41B, 42B Outer ring of spiral wound gasket
41D, 42D Thrust abutment
46 Elastic-Deformation Implement
47 48 Stop section
51 61 Elastic body
52 62 Washer
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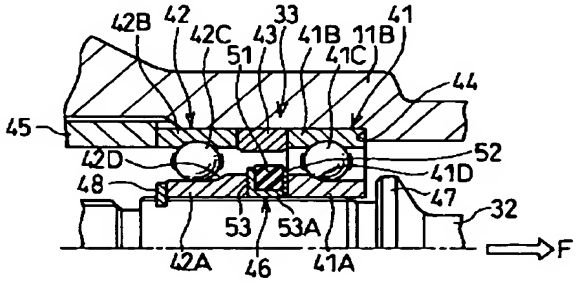
(54)【発明の名称】　電動パワーステアリング装置

(57)【要約】
【課題】　電動モータに結合される駆動軸の軸方向移動を許容して衝撃吸収可能とする電動パワーステアリング装置において、軸受装置による駆動軸の支持状態を向上し、電動モータのトルク伝達性を向上すること。
【解決手段】　電動パワーステアリング装置１０において、電動モータ３０に結合された駆動軸３２を支持する軸受装置３３を２個のアンギュラ玉軸受４１、４２により構成し、軸受４１、４２の内輪４１Ａ、４２Ａに設けたスラスト受面４１Ｄ、４２Ｄを背中合せになるように並置し、両軸受４１、４２の内輪４１Ａ、４２Ａの間に弾性変形具４６を介装し、両内輪４１Ａ、４２Ａを駆動軸３２に隙間嵌めし、且つ２つの内輪係止部４７、４８の間に挟持したもの。



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【特許請求の範囲】

【請求項１】　ステアリング軸に接続されたピニオン軸をラック軸に噛合いさせ、

電動モータに結合された駆動軸を回転自在に支持する軸受装置を備えるとともに、該駆動軸に駆動ギヤを設け、該駆動ギヤに噛合う中間ギヤを上記ピニオン軸に接続してなる電動パワーステアリング装置において、

前記軸受装置が、内輪又は外輪の転走面の一側にスラスト受面を備えた２個のアンギュラ軸受を、それらのスラスト受面が背面合せになるように並置し、

２個のアンギュラ軸受の内輪にスラスト受面を備えた場合には、両軸受の内輪の間に弾性変形具を介装し、両内輪を駆動軸に隙間嵌めし、且つ該駆動軸に設けた２つの内輪係止部の間に挟持するとともに、両軸受の外輪をハウジングの側に固定配置し、

２個のアンギュラ軸受の外輪にスラスト受面を備えた場合には、両軸受の外輪の間に弾性変形具を介装し、両外輪をハウジングに隙間嵌めし、且つ該ハウジングに設けた２つの外輪係止部の間に挟持するとともに、両軸受の内輪を駆動軸の側に固定配置してなることを特徴とする電動パワーステアリング装置。

【請求項２】　前記２個のアンギュラ軸受のスラスト受面を備えた内輪又は外輪を挟持する２つの係止部のうち、一方の係止部が駆動軸又はハウジングに設けた段差部、他方の係止部が駆動軸又はハウジングの該段差部と一定の距離をなす位置に設けた溝に係着されるストッパリングである請求項１記載の電動パワーステアリング装置。

【請求項３】　前記弾性変形具が、弾性体と、弾性体の一方の面の側に接合した座金と、弾性体の他方の面の側に組付けた座金とからなる請求項１又は２記載の電動パワーステアリング装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は電動パワーステアリング装置に関する。

【０００２】

【従来の技術】電動パワーステアリング装置は、ステアリング軸に接続されたピニオン軸をラック軸に噛合いさせるとともに、電動モータに結合された駆動軸にウォームギヤを設け、該ウォームギヤに噛合うウォームホイールをピニオン軸に接続し、モータのトルクをラック軸に伝えることで操舵アシストする。

【０００３】然るに、ウォームギヤとウォームホイールの歯面同士は加工上、作動上の必要から適度なバックラッシュが設定されている。ところが、電動パワーステアリング装置では、ステアリングホイールの操作或いは路面から入力される振動により、動力の伝達方向が反転することがある。このような反転駆動時には、ウォームギヤ又はウォームホイールの今まで当接していた歯面の裏

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側の歯面が、バックラッシュ分だけ急に移動して相手の歯面に衝突し、叩き音を生ずる。

【０００４】また、電動パワーステアリング装置では、操舵中にタイヤが縁石に乗り上げる等により、ラック軸のストロークが急停止せしめられたとき、電動モータはたとえ給電を停止しても慣性により回転し続けようとするため、電動モータに接合されている駆動軸の慣性推力がトルク伝達経路に損傷を招く虞もある。

【０００５】従来技術では、実開平6-39665 号公報に記載の如く、上述の叩き音を低減したり、トルク伝達経路の損傷を防止するため、電動モータに結合された駆動軸をギヤハウジングに支持する軸受装置を２個の軸受で構成し、この２個の軸受の内輪と外輪をともに駆動軸とギヤハウジングに隙間嵌めするとともに、両軸受の間に皿ばねを介装している。これにより、電動パワーステアリング装置の反転駆動時や、タイヤの縁石乗り上げ時等に、駆動軸上の皿ばねを、駆動軸上の一方の軸受により他方の軸受に対して押し込んで圧縮変形させ、該駆動軸を２個の軸受のうちの一方のものとともに軸方向の一方側に移動可能とし、結果として、ウォームギヤの歯面に生ずる衝撃力の緩和による歯面同士の叩き音の低減、或いは駆動軸の慣性推力によるトルク伝達経路の損傷の回避を図るものである。

【０００６】

【発明が解決しようとする課題】①駆動軸をギヤハウジングに支持する軸受装置が、２個の軸受の間の皿ばねを圧縮変形させるとき、駆動軸は一方の軸受の全体（内輪及び外輪）とともに軸方向に移動する。このとき、一方の軸受の外輪がギヤハウジングに対して滑り、他方の軸受の内輪が駆動軸に対して滑る必要がある。従って、２個の軸受は、前述した如く、それらの内輪と外輪をともに駆動軸とギヤハウジングに隙間嵌めする必要があり、ギヤハウジングと駆動軸の間での径方向のがたが大きく、駆動軸の支持状態が悪く、ひいては電動モータのトルク伝達性を損なう。

【０００７】②２個の軸受の間に介装した皿ばねが駆動軸に付与する予圧力は、駆動軸に設けた内輪のロックナットにより皿ばねを予圧縮することにより付与される。このため、駆動軸の軸方向移動を許容して一定の衝撃吸収性能を確保するに必要な予圧力を駆動軸に付与するためには、ロックナットの締め加減によって皿ばねに付与する予圧縮量を微妙に調整する必要があり、軸受装置が駆動軸に付与する予圧調整に困難がある。

【０００８】本発明の課題は、電動モータに結合される駆動軸の軸方向移動を許容して衝撃吸収可能とする電動パワーステアリング装置において、軸受装置による駆動軸の支持状態を向上し、電動モータのトルク伝達性を向上することにある。

【０００９】また、本発明の課題は、軸受装置が駆動軸に付与する予圧設定を簡易に高精度化することにある。

【００１０】
【課題を解決するための手段】請求項１の発明は、ステアリング軸に接続されたピニオン軸をラック軸に噛合いさせ、電動モータに結合された駆動軸を回転自在に支持する軸受装置を備えるとともに、該駆動軸に駆動ギヤを設け、該駆動ギヤに噛合う中間ギヤを上記ピニオン軸に接続してなる電動パワーステアリング装置において、前記軸受装置が、内輪又は外輪の転走面の一側にスラスト受面を備えた２個のアンギュラ軸受を、それらのスラスト受面が背面合せになるように並置し、２個のアンギュラ軸受の内輪にスラスト受面を備えた場合には、両軸受の内輪の間に弾性変形具を介装し、両内輪を駆動軸に隙間嵌めし、且つ該駆動軸に設けた２つの内輪係止部の間に挟持するとともに、両軸受の外輪をハウジングの側に固定配置し、２個のアンギュラ軸受の外輪にスラスト受面を備えた場合には、両軸受の外輪の間に弾性変形具を介装し、両外輪をハウジングに隙間嵌めし、且つ該ハウジングに設けた２つの外輪係止部の間に挟持するとともに、両軸受の内輪を駆動軸の側に固定配置してなるようにしたものである。
【００１１】請求項２の発明は、請求項１の発明において更に、前記２個のアンギュラ軸受のスラスト受面を備えた内輪又は外輪を挟持する２つの係止部のうち、一方の係止部が駆動軸又はハウジングに設けた段差部、他方の係止部が駆動軸又はハウジングの該段差部と一定の距離をなす位置に設けた溝に係着されるストッパリングであるようにしたものである。
【００１２】請求項３の発明は、請求項１又は２の発明において更に、前記弾性変形具が、弾性体と、弾性体の一方の面の側に接合した座金と、弾性体の他方の面の側に組付けた座金とからなるようにしたものである。
【００１３】
【作用】請求項１の発明によれば下記①、②の作用がある。
①電動パワステアリング装置の反転駆動時や、タイヤの縁石乗り上げ時等に、駆動軸に過大推力が作用すると、２個の軸受の内輪の間（又は２個の軸受の外輪の間）に介装された弾性変形具が圧縮変形し、２個の軸受のうちの一方の軸受の内輪が当該軸受の外輪に対して（２個の軸受のうちの一方の軸受の外輪が当該軸受の内輪に対して）軸方向に相対移動（離隔移動）する。これにより、駆動ギヤの歯面に生ずる衝撃力を緩和して歯面同士の叩き音を低減し、或いは駆動軸の慣性推力によるトルク伝達経路の損傷を回避する。
【００１４】②２個の軸受は、内輪だけ（又は外輪だけ）を駆動軸（又はギヤハウジング）に隙間嵌めし、他方の外輪（又は内輪）はギヤハウジング（又は駆動軸）に固定配置するものであるから、内外輪の両方を隙間嵌めするものに比して、ギヤハウジングと駆動軸の間での径方向のがたを小さくし、結果として、軸受装置による駆動軸の支持状態を向上し、電動モータのトルク伝達性を向上できる。更に、隙間嵌め個所を減らすことで摺動嵌合部の磨耗が無く、耐久性上優位となる。
【００１５】請求項２の発明によれば下記③の作用がある。
③２個の軸受の内輪の間（又は外輪の間）に介装した弾性変形具が駆動軸に付与する予圧力は、駆動軸（又はギヤハウジング）に設けた段差部からなる一方の係止部と、溝に設けたストッパリングからなる他方の係止部とがなす一定の間隔に基づき弾性変形具に付与される一定の予圧縮量により直ちに一義的に定められる。従って、駆動軸の軸方向移動を許容して一定の衝撃吸収性能を確保するに必要な予圧力を、２つの係止部の間隔の設定のみにより一義的に定めることができ、軸受装置が駆動軸に付与する予圧設定を簡易に高精度化できる。
【００１６】請求項３の発明によれば下記④、⑤の作用がある。
④弾性変形具は、２枚の座金の間に弾性体を挟んで相隣る内輪の間（又は外輪の間）に介装するものであり、弾性体をそれらの内輪の間（又は外輪の間）で安定的に弾性変形させることができる。
【００１７】⑤弾性変形具は、一方の座金を弾性体の一方の面の側に接合し、他方の座金を弾性体の他方の面の側に組付けるものであるから、それら３部品のサブ組性を向上でき、軸受装置への組立性を向上できる。
【００１８】
【発明の実施の形態】図１は電動パワーステアリング装置を一部破断して示す正面図、図２は図１のII–II 線に沿う断面図、図３は図２のIII–III 線に沿う断面図、図４は図３の要部拡大断面図、図５は駆動軸の移動状態を示す断面図、図６は弾性変形具を示す断面図、図７は電動パワーステアリング装置の変形例を示す要部拡大断面図、図８は駆動軸の移動状態を示す断面図、図９は弾性変形具を示す断面図である。
【００１９】電動パワーステアリング装置１０は、図１、図２に示す如く、不図示のブラケットにより車体フレーム等に固定されるハウジング１１（第１～第３のハウジング１１Ａ～１１Ｃ）を有する。そして、ステアリングホイールが結合されるステアリング軸１２にトーションバー１３を介してピニオン軸１４を連結し、このピニオン軸１４にピニオン１５を設け、このピニオン１５に噛合うラック１６Ａを備えたラック軸１６を第１ハウジング１１Ａに左右動可能に支持している。ステアリング軸１２とピニオン軸１４の間には、操舵トルク検出装置１７を設けてある。尚、ステアリング軸１２とピニオン軸１４は軸受１２Ａ、１４Ａ、１４Ｂを介してハウジング１１に支持される。
【００２０】操舵トルク検出装置１７は、図２に示す如く、ステアリング軸１２、ピニオン軸１４に係合している円筒状のコア１７Ｃを囲む２個の検出コイル１７Ａ、

１７Ｂを第３ハウジング１１Ｃに設けている。コア１７Ｃは、ピニオン軸１４のガイドピン１７Ｄに係合する縦溝１７Ｅを備えて軸方向にのみ移動可能とされるとともに、ステアリング軸１２のスライダピン１７Ｆに係合するスパイラル溝１７Ｇを備える。これにより、ステアリングホイールに加えた操舵トルクがステアリング軸１２に付与され、トーションバー１３の弾性ねじり変形により、ステアリング軸１２とピニオン軸１４の間に回転方向の相対変位を生ずると、ステアリング軸１２とピニオン軸１４の回転方向の変位がコア１７Ｃを軸方向に変位させるものとなり、このコア１７Ｃの変位による検出コイル１７Ａ、１７Ｂの周辺の磁気的変化に起因する検出コイル１７Ａ、１７Ｂのインダクタンスが変化する。即ち、コア１７Ｃがステアリング軸１２側へ移動すると、コア１７Ｃが近づく方の検出コイル１７Ａのインダクタンスが増加し、コア１７Ｃが遠ざかる方の検出コイル１７Ｂのインダクタンスが減少し、このインダクタンスの変化により操舵トルクを検出できる。

【００２１】第１ハウジング１１Ａ内でラック軸１６の一端を挟んでピニオン１５と相対する部分に設けられているシリンダ部１８には、図２に示す如く、ラックガイド１９が内蔵され、ラックガイド１９（ブッシュ１９Ａ）はシリンダ部１８に被着されるキャップ２０により背面支持されるばね２１によりラック軸１６の側に弾発され、ラック軸１６のラック１６Ａをピニオン１５に押し付けるとともに、ラック軸１６の一端を摺動自在に支持する。尚、ラック軸１６の他端側は軸受２２により支持される。また、ラック軸１６の中間部には連結ボルト２２Ａ、２２Ｂにより左右のタイロッド２３Ａ、２３Ｂが連結される。

【００２２】第２ハウジング１１Ｂは、図３に示す如く、電動モータ３０を支持する。電動モータ３０の出力軸にはクラッチ３１を介して駆動軸３２が結合され、駆動軸３２は軸受装置３３と軸受３４によりハウジング１１Ｂに両端支持されるとともに、駆動軸３２の中間部にウォームギヤ（駆動ギヤ）３５を一体に備える。そして、このウォームギヤ３５に噛合うウォームホイール３６（中間ギヤ）をピニオン軸１４の中間部に固定してある。電動モータ３０の発生トルクは、ウォームギヤ３５とウォームホイール３６の噛合い、ピニオン１５とラック１６Ａの噛合いを介してラック軸１６に操舵アシスト力となって付与され、運転者がステアリング軸１２に付与する操舵力をアシストする。

【００２３】然るに、軸受装置３３は、図４に示す如く、内輪４１Ａと外輪４１Ｂと転走体４１Ｃからなるアンギュラ軸受４１（アンギュラ玉軸受）と、内輪４２Ａと外輪４２Ｂと転送体４２Ｃからなるアンギュラ軸受４２（アンギュラ玉軸受）の２個の軸受を用いて構成される。このとき、軸受４１は内輪４１Ａの転走面の一側にスラスト受面４１Ｄを備え、軸受４２は内輪４２Ａの転走面の一側にスラスト受面４２Ｄを備え、軸受４１と軸受４２はそれらのスラスト受面４１Ｄ、４２Ｄが互いに背面合せになるように並置される。そして、軸受４１と軸受４２は、それらの外輪４１Ｂ、４２Ｂの間にスペーサ４３を挟んでハウジング１１Ｂに挿入され、軸受４１の外輪４１Ｂをハウジング１１Ｂの段差部４４に衝合した状態で、ハウジング１１Ｂに螺合されるロックナット４５により軸受４２の外輪４２Ｂを加圧することにて、それらの外輪４１Ｂ、４２Ｂをハウジング１１Ｂの側に固定配置する。このとき、軸受４１と軸受４２は、それらの内輪４１Ａ、４２Ａの間に予圧縮された弾性変形具４６を介装し、両内輪４１Ａ、４２Ａを駆動軸３２に軸方向に相対移動可能となるように隙間嵌めし、且つ駆動軸３２に設けた第１と第２の内輪係止部４７、４８の間に挟持する。第１係止部４７は駆動軸３２に設けたつば状段差部であって内輪４１Ａを衝合可能とされ、第２係止部４８は駆動軸３２に設けた溝に係着されたストッパリングであり、第１係止部４７と第２係止部４８は弾性変形具４６に所望の予圧縮量（一定の衝撃吸収性能）を付与するに必要な一定の距離をなす位置に設定される。

【００２４】弾性変形具４６は、図６に示す如く、四角断面円環状のゴムからなる弾性体５１と、弾性体５１の一方の側面に焼付きにて結合した平板円板状座金５２と、弾性体５１の他方の側面の側に組付けられるＬ字断面環状座金５３とからなる。座金５３は、筒部５３Ａを弾性体５１の内周面に嵌合して組付けられる。そして、弾性変形具４６は、弾性体５１、座金５２、５３の外径を内輪４１Ａ、４２Ａより大径、座金５２、５３の筒部５３Ａの内径を内輪４１Ａ、４２Ａと同等にして、両内輪４１Ａ、４２Ａの間で座金５２、５３を介することにて弾性体５１を確実に挟圧可能としている。同時に、座金５２、座金５３の筒部５３Ａの内径を弾性体５１の内径より内方に突出させ、座金５２と座金５３の筒部５３Ａとの衝合により弾性体５１の圧縮ストローク端を規制可能としている。即ち、後述の(2-2)、(2-3)で弾性変形具４６が２個の内輪４１Ａ、４２Ａに挟まれて圧縮変形せしめられるとき、座金５２と座金５３の筒部５３Ａとが衝合するタイミングをその圧縮ストローク端とする。

【００２５】以下、電動パワーステアリング装置１０の動作について説明する。

(1) 操舵トルク検出装置１７が検出した操舵トルクが所定値より低いとき、操舵アシスト力は不要であり、電動モータ３０は駆動されない。

【００２６】(2) 操舵トルク検出装置１７が検出した操舵トルクが所定値を越えるとき、操舵アシスト力を必要とするから、電動モータ３０が駆動される。電動モータ３０の発生トルクが、駆動軸３２を回転させ、ウォームギヤ３５とウォームホイール３６の噛合い、ピニオン１５とラック１６Ａの噛合いを介してラック軸１６に付与

される。

【００２７】(2-1) 通常作動時には、駆動軸３２のウォームギヤ３５とウォームホイール３６との間に反力が生ずるが、軸受装置３３の弾性変形具４６が駆動軸３２に付与している予圧力がその反力より大きく設定されているから、駆動軸３２は軸方向に移動しない（図４）。従って、電動モータ３０の発生トルクはそのままウォームホイール３６に伝えられる。

【００２８】(2-2) ステアリングホイールの操舵或いは路面から入力される振動により、動力の伝達方向が反転する反転駆動時に、ウォームギヤ３５とウォームホイール３６がそれらのバックラッシュの存在によってそれらの歯面同士を当接せしめるときには、ウォームギヤ３５とウォームホイール３６との間に上述(2-1) より大きな反力Ｆが生ずる。この場合には、軸受装置３３の弾性変形具４６が駆動軸３２に付与している予圧力よりもその反力の方が大きくなり、２個の軸受４１、４２の内輪４１Ａ、４２Ａの間に介装された弾性変形具４６が圧縮変形し、２個の軸受４１、４２のうちの一方の例えば軸受４２の内輪４２Ａが当該軸受４２の外輪４２Ｂに対して軸方向に相対移動するものとなって駆動軸３２が軸方向に移動する（図５）。これにより、ウォームギヤ３５の歯面に生ずる衝撃力を弾性変形具４６の弾性変形により緩和し、歯面同士の叩き音を低減する。

【００２９】(2-3) 上述(2-1) の操舵中にタイヤが縁石に乗り上げる等により、ラック軸１６のストロークが急停止せしめられると、電動モータ３０がたとえ給電を停止されても慣性により回転し続けようとし、電動モータ３０に結合されている駆動軸３２に慣性推力Ｆが作用する。このとき、慣性推力は軸受装置３３の弾性変形具４６が駆動軸３２に付与している予圧力を上回り、２個の軸受４１、４２の内輪４１Ａ、４２Ａの間に介装された弾性変形具４６が圧縮変形し、２個の軸受４１、４２のうちの一方の例えば軸受４２の内輪４２Ａが当該軸受４２の外輪４２Ｂに対して軸方向に相対移動するものとなって駆動軸３２が軸方向に移動する（図５）。これにより、駆動軸３２に作用する慣性推力を弾性変形具４６の弾性変形によって吸収し、トルク伝達経路の損傷を回避する。

【００３０】従って、本実施形態によれば以下の作用がある。

①電動パワステアリング装置１０の反転駆動時や、タイヤの縁石乗り上げ時等に、駆動軸３２に過大推力が作用すると、２個の軸受４１、４２の内輪４１Ａ、４２Ａの間に介装された弾性変形具４６が圧縮変形し、２個の軸受４１、４２のうちの一方の例えば軸受４２の内輪４２Ａが当該軸受４２の外輪４２Ｂに対して軸方向に相対移動（離隔移動）する。これにより、ウォームギヤ３５の歯面に生ずる衝撃力を緩和して歯面同士の叩き音を低減し、或いは駆動軸３２の慣性推力によるトルク伝達経路の損傷を回避する。

【００３１】②２個の軸受４１、４２は、内輪４１Ａ、４２Ａだけを駆動軸３２に隙間嵌めし、他方の外輪４１Ｂ、４２Ｂはギヤハウジング１１Ｂに固定配置するものであるから、内外輪の両方を隙間嵌めするものに比して、ギヤハウジング１１Ｂと駆動軸３２の間での径方向のがたを小さくし、結果として、軸受装置３３による駆動軸３２の支持状態を向上し、電動モータ３０のトルク伝達性を向上できる。更に、隙間嵌め個所を減らすことで摺動嵌合部の磨耗が無く、耐久性上優位となる。

【００３２】③２個の軸受４１、４２の内輪４１Ａ、４２Ａの間に介装した弾性変形具４６が駆動軸３２に付与する予圧力は、駆動軸３２に設けた段差部からなる一方の第１係止部４７と、溝に設けたストッパリングからなる第２係止部４８とがなす一定の間隔に基づき弾性変形具４６に付与される一定の予圧縮量により直ちに一義的に定められる。従って、駆動軸３２の軸方向移動を許容して一定の衝撃吸収性能を確保するに必要な予圧力を、２つの係止部４７、４８の間隔の設定のみにより一義的に定めることができ、軸受装置３３が駆動軸３２に付与する予圧設定を簡易に高精度化できる。

【００３３】④弾性変形具４６は、２枚の座金５２、５３の間に弾性体５１を挟んで相隣る内輪４１Ａ、４２Ａの間に介装するものであり、弾性体５１をそれらの内輪４１Ａ、４２Ａの間で安定的に弾性変形させることができる。

【００３４】⑤弾性変形具４６は、一方の座金５２を弾性体５１の一方の面の側に接合し、他方の座金５３を弾性体５１の他方の面の側に組付けるものであるから、それら３部品のサブ組性を向上でき、軸受装置３３への組立性を向上できる。

【００３５】図７～図９は、本発明の変形例である。この変形例が図４～図６の実施例と異なる点は、弾性変形具４６の構成の変更にある。図７～図９の弾性変形具４６は、四角断面円環状のゴムからなる弾性体６１と、弾性体６１の一方の側面に焼付きにて接合した平板円板状座金６２と、弾性体６１の他方の側面の側に組付けたコ字断面環状座金６３とからなる。座金６３は、内筒部６３Ａと外筒部６３Ｂの間に弾性体６１を嵌合して組付けられる。そして、弾性変形具４６は、座金６２、６３の外径を内輪４１Ａ、４２Ａより大径、座金６２、６３の内径を内輪４１Ａ、４２Ａと同等にして、両内輪４１Ａ、４２Ａの間で座金６２、６３を介することにて弾性体６１を確実に挟圧可能としている。同時に、座金６２、座金６３の内筒部６３Ａの内径を弾性体６１の内径より内方に突出させ、座金６２と座金６３の内筒部６３Ａとの衝合により弾性体６１の圧縮ストローク端を規制可能としている。

【００３６】以上、本発明の実施の形態を図面により詳述したが、本発明の具体的な構成はこの実施の形態に限

られるものではなく、本発明の要旨を逸脱しない範囲の設計の変更等があっても本発明に含まれる。例えば、本発明の軸受装置は、２個のアンギュラ軸受（アンギュラ玉軸受）の外輪にスラスト受面を備えるものとし、両軸受の外輪の間に弾性変形具を介装し、両外輪をハウジングに隙間嵌めし、且つ該ハウジングに設けた２つの外輪係止部の間に挟持するとともに、両軸受の内輪を駆動軸の側に固定配置しても良い。

【００３７】また、本発明が適用される電動パワーステアリング装置において、駆動ギヤと中間ギヤは、ウォーム減速機を構成するものに限らず、駆動軸に推力を発生させる歯車、例えばはすば歯車、かさば歯車等の他の歯車からなるものであっても良い。

【００３８】

【発明の効果】以上のように本発明によれば、電動モータに結合される駆動軸の軸方向移動を許容して衝撃吸収可能とする電動パワーステアリング装置において、軸受装置による駆動軸の支持状態を向上し、電動モータのトルク伝達性を向上できる。

【００３９】また、本発明によれば、軸受装置が駆動軸に付与する予圧設定を簡易に高精度化することができる。

【図面の簡単な説明】

【図１】図１は電動パワーステアリング装置を一部破断して示す正面図である。

【図２】図２は図１のII-II 線に沿う断面図である。

【図３】図３は図２のIII-III 線に沿う断面図である。

＊【図４】図４は図３の要部拡大断面図である。

【図５】図５は駆動軸の移動状態を示す断面図である。

【図６】図６は弾性変形具を示す断面図である。

【図７】図７は電動パワーステアリング装置の変形例を示す要部拡大断面図である。

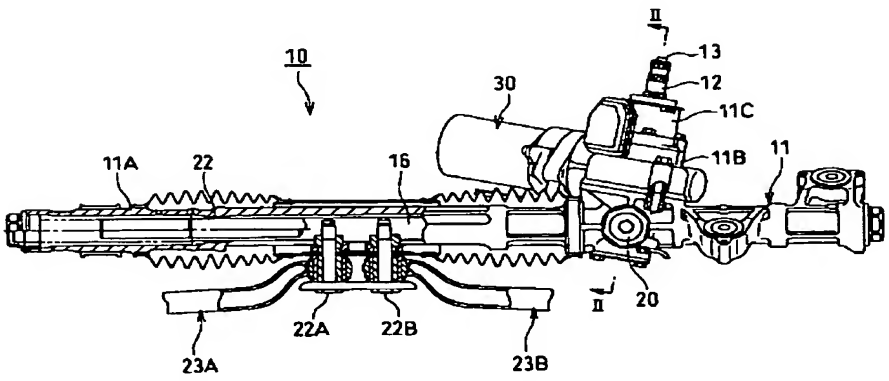
【図８】図８は駆動軸の移動状態を示す断面図である。

【図９】図９は弾性変形具を示す断面図である。

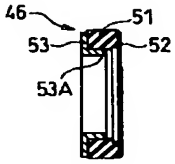
【符号の説明】

１０　電動パワーステアリング装置
１１Ｂ　ハウジング
１２　ステアリング軸
１４　ピニオン軸
１６　ラック軸
３０　電動モータ
３２　駆動軸
３３　軸受装置
３５　ウォームギヤ（駆動ギヤ）
３６　ウォームホイール（中間ギヤ）
４１、４２　軸受
４１Ａ、４２Ａ　内輪
４１Ｂ、４２Ｂ　外輪
４１Ｄ、４２Ｄ　スラスト受面
４６　弾性変形具
４７、４８　係止部
５１、６１　弾性体
５２、６２　座金
５３、６３　座金

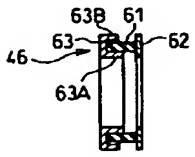
【図１】



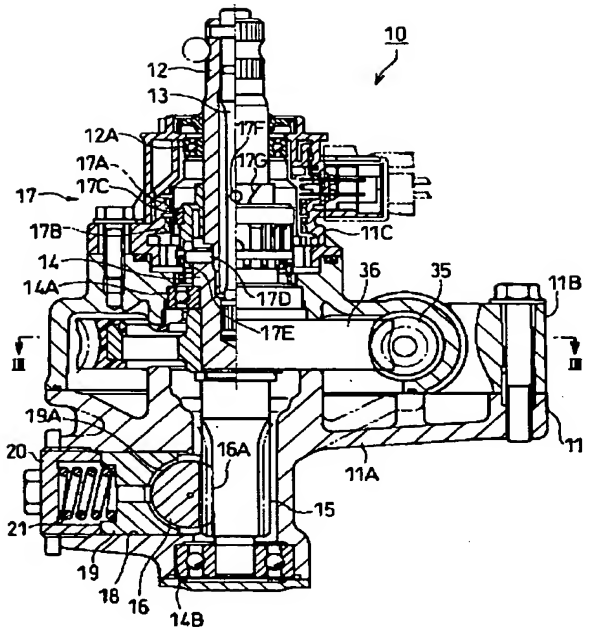
【図６】



【図９】



【図２】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17B
14
14A
17F
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11C
36
35
11B
17D
17E
II
II
19A
20
21
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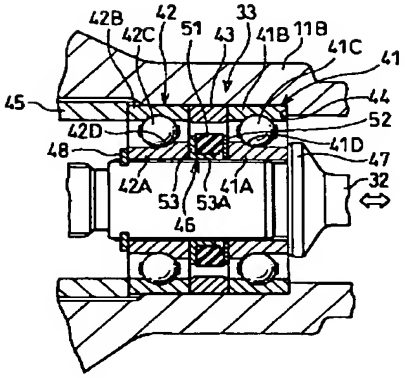
18
16
14B
16A
15
11A
11

【図４】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11B
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41D
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42A
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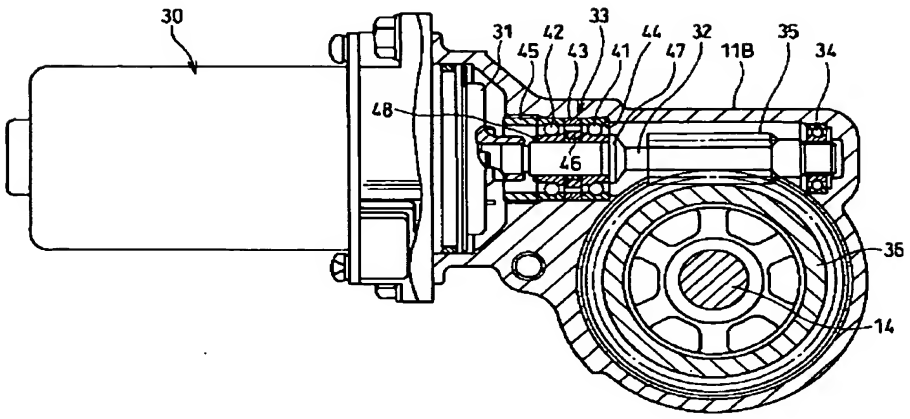
53A
41A
32
46

【図３】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11B
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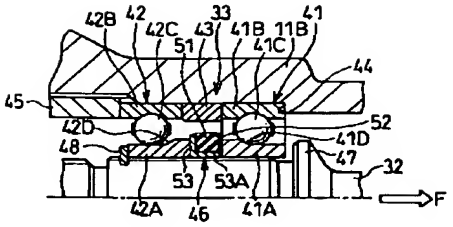
14

【図５】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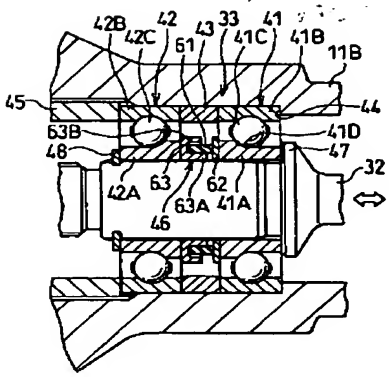
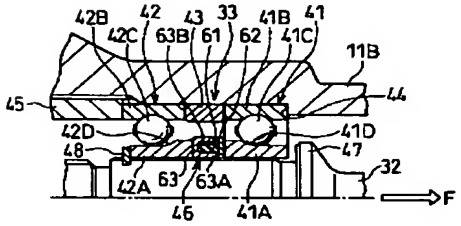
51
41C
44
45
42D
52
41D
48
47
32
53
53A
42A
46
41A
F

【図７】


42B
42
42C
43
33
41
61
41C
41B
11B
44
45
63B
41D
48
47
32
42A
63
62
63A
41A
46

【図８】


42B
42
43
33
41B
41
42C
63B
61
62
41C
11B
44
45
42D
41D
48
47
32
42A
63
63A
46
41A
F